

Washington—Engineer and Engineer Advocate

By Major John Richard Boulé II

George Washington was a great early American engineer. Hundreds of books have been written about his accomplishments as a Virginia planter, a military commander, a noble statesman, and a symbol for the new American nation. Although Washington's surveying achievements are fairly well publicized, almost nothing has been written about Washington the engineer and engineer advocate. In this article, I will show that the father of our country was an accomplished engineer who served as a strong proponent for establishing American engineering institutions.



George Washington did not have a formal education. However, from the time he was a young man, he engaged in engineering activities. As he continued to mature, the same skills that made him a good surveyor, builder, and innovator were applied to other pursuits. These talents and experiences formed the solid foundation upon which Washington built his more notable achievements, much the way that Lee and MacArthur applied their engineering backgrounds to become two of the greatest American practitioners of operational art. As you will see, it is time to add Washington to the long list of great American engineers.

Defining Engineers

Engineers have been labeled as professionals who apply math and science to create something of value¹—a rather mundane definition. Theodore Von Karman, an

aerospace engineer, put it differently. “Scientists discover the world that exists; *engineers create the world that never was.*”² This definition fits Washington. In many ways, he was indispensable in creating a world that had not existed in his time. He did this on a grand scale in his efforts as commander of the Continental Army and first President of the United States. He also did it on a smaller scale in Virginia as a surveyor, planter, businessman, and gentleman. Washington created through natural talent, devotion, resoluteness, and hard work.

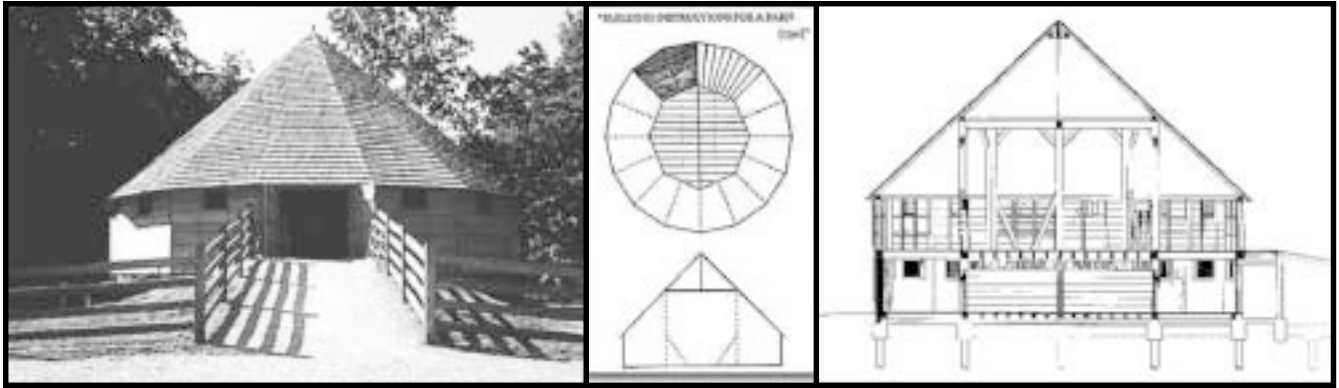
Engineers throughout history have used this formula for success. Rudyard Kipling recognized these traits when he wrote *Sons of Martha*, his ode to engineers. His ode defends Martha's comment to Jesus about her sister Mary (Luke 10:42). In Kipling's poem, now adopted as the poem for engineers, he writes:

“The Sons of Mary seldom bother, for they have inherited the good part; But the Sons of Martha favour their Mother of the careful soul and the troubled heart...They say to the mountains, ‘Be ye removed.’ They say to the floods, ‘Be dry.’ Under their rods are the rocks reproved—they are not afraid of that which is high. Then do the hilltops shake to the summit—then is the bed of the deep laid bare, That the Sons of Mary may overcome it, pleasantly sleeping and unaware.”³



A survey, commissioned by Lord Fairfax, and a map of Alexandria, Virginia, were done by George Washington.

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Washington's grain-threshing structure was rebuilt at Mount Vernon. He created these plans while President of the United States.

Washington was definitely a Son of Martha. He fearlessly persevered through many daunting challenges until he prevailed. Virginians, and later all Americans, benefited from his efforts.

Engineering in Washington's Time

Washington lived most of his life before the advent of the Industrial Revolution. Engineering, as we classify it today, did not exist in his day. Although colleges like Harvard and Columbia (then called King's College) operated in the colonies, America did not have a school where formal engineering skills were taught. In Europe, engineering instruction often focused on fortifications and siege craft. Even the Great Wall of China, finished in 1640, was barely 100 years old when Washington was born!

It is safe to say that American engineering was in its infancy during Washington's time. The first engineered structure in America, the Castillo de San Marcos, was designed and constructed in Florida in 1695, only 37 years before Washington's birth.⁴ Some of the most famous engineering projects completed during Washington's time were the first municipal pumped waterworks in Bethlehem, Pennsylvania, in 1755, and the survey of the Mason-Dixon line, officially designating the Pennsylvania-Virginia boundary, in 1767. Engineers were not even legally recognized as experts in America until 1782, one year before the Revolutionary War concluded.⁵ Therefore, we cannot expect Washington to be involved in *major* engineering projects; they simply did not exist. Likewise, we cannot consider him an engineer unless he demonstrated some engineering credentials.

Washington, Engineering Qualifications

As a young man, Washington learned to survey. He had a natural talent for mathematics. At the age of 16, he apprenticed with several accomplished surveyors on a month-long trip to the Blue Ridge Mountains to survey Lord Fairfax's lands.⁶ He mastered the trade quickly, earning an appointment as county surveyor of Culpeper County, Virginia, at the age of 17.

Washington later used his knowledge of topography and mapmaking to produce drawings of the Ohio River Valley in 1753, while on a dangerous mission to deliver a message to the French demanding their withdrawal from the region. These sketches represented the state of geographical knowledge of the area at the outbreak of the French and Indian War that occurred shortly after his trip.⁷

Even though he was heavily burdened as a Virginia planter, businessman, and legislator; commander of the Continental Army for eight years; and President of the United States for eight years, he is credited with conducting an extensive number of surveys. During his lifetime, Washington surveyed more than 200 tracts of land consisting of 60,000-plus acres. He is credited with drawing more than 100 maps,⁸ including a map of the city of Alexandria. He was involved with L'Enfant in planning the technical layout for the future capital city that would bear his name.

Washington, Innovator and Builder

In the true spirit of engineering, George Washington demonstrated his ability to create things to solve problems. Many of his innovations were designed to expand his business and to make farming more efficient and his residence more comfortable and stately. He engineered farm tools and wheat-processing facilities and designed and expanded his country estate. He was also involved in a land reclamation and canal project in the Dismal Swamp of southeastern Virginia and northeastern North Carolina.

Plow Invention

Washington's engineering achievements were numerous and varied in scale. By 1770, he had designed a new plow,⁹ which was actually a combination plow and seeder. Seeds were placed in a perforated cylinder, and as the plow was moved, the cylinder rotated releasing the seeds. After experiencing some clogging, Washington redesigned the cylinder incorporating funnel-shaped holes that made it less likely for the seeds to jam.¹⁰ He had demonstrated the tried and true engineer technique of trial and error to solve a practical problem.



Mount Vernon was largely designed and built by Washington without the assistance of an architect.

Mount Vernon Expansion

Washington greatly expanded the simple Mount Vernon farmhouse he inherited. Beginning in 1758, he turned the 1 1/2-story structure with several rooms into a 2 1/2-story, twenty-room mansion without the aid of an architect.¹¹ He also designed and built all twelve outbuildings placed around the central structure. Attempting to turn his property into an estate worthy of a country gentleman, Washington added a stunning two-story piazza overlooking the Potomac River and an elegant cupola on the top of his estate house.¹² With Mount Vernon, Washington demonstrated a flare for architecture.

Agricultural Facility

One of Washington's most innovative creations was his two-floor, sixteen-sided (or circular) barn. After experiencing mixed results from growing tobacco, he converted many of his fields to wheat. To separate the grain from the stalk, treading animals were commonly used. Washington wanted to create a facility that would keep the working animals out of the weather and protect his grain from theft.

In 1792, construction of his 52-foot-diameter barn began. (Remember, Washington was President at the time!) He had drawn diagrams of the structure and had done many computations to determine the bill of materials. His design specified a brick first floor and a wooden second floor. Washington's own calculations called for 30,280 bricks.¹³ In the center of the barn was an octagonal room designed to store the separated grain. Horses would walk up an earthen ramp to the second floor and then tread on the harvested wheat while walking in a circle. Washington designed a space of 1 to 1 1/2 inches between floorboards to allow the separated grain to fall to the first floor. The grain was then placed in the octagonal room until it could be transported to his gristmill. The circular barn can be thought of as Washington's own threshing machine. This creation represented true originality in agricultural production.

Land Reclamation and Canal Construction

Washington spent his years between the French and Indian and Revolutionary Wars improving his estate and expanding

his land holdings. In 1763, he visited the Great Dismal Swamp on the eastern border of Virginia and North Carolina, separating the Chesapeake Bay and Albemarle Sound.¹⁴ Here he saw opportunities. Once again demonstrating his engineering vision, he suggested draining the swamp and digging a north-south waterway to connect the Chesapeake and Albemarle.¹⁵ Joining with other southern colonial businessmen, he formed two syndicates hoping to drain the swamp, harvest the trees, and use the land for farming. Washington directed the surveying and construction of a 5-mile-long ditch. By adding another trench, Washington's ditch provided a means to move logs and drain the swamp. The investors soon realized, however, that the task of draining the Great Dismal Swamp to reclaim the land was too difficult.

However, the idea of connecting the Chesapeake and the Albemarle by an inland waterway had other merit to Washington. In 1793, he and Virginia Governor Patrick Henry helped form the Dismal Swamp Canal Company to build a canal for flat-bottomed boats. The Great Dismal Swamp Canal—the oldest continually operating man-made canal in the United States—was completed by hand in 1805, six years after Washington's death.¹⁶ In 1987, this canal was designated as a national civil engineering landmark. Today the canal is operated by the U.S. Army Corps of Engineers and provides a means for boaters to traverse between the two states, avoiding ocean exposure.

Other Contributions

The canal, estate, barn, and plow represented manifestations of Washington's engineering ability. His construction ability was initially displayed in building Fort Mifflin, a stockade that he fought behind in 1754 during a losing battle with the French. In 1785, Washington became president of the Potomac Navigation Company. The company's goal was to connect a more navigable Potomac River with the Ohio River system using a portage road. Another engineer completed the road, later named the National Road.¹⁷

When combined with his cartographic portfolio, and considering the context of his time, there can be little doubt that Washington should be classified as an accomplished

engineer. Yet, his greatest contribution to American engineering was his advocacy of developing native engineering institutions.

Washington, Master Advocate for Future Master Builders

The 19th century was a glorious time for engineering development in the United States. Engineers were often referred to as *master builders*, and chief engineers had absolute authority over all the operational, technical, logistical, financial, and administrative functions of major projects. Military engineers led many of America's largest engineering projects. These American engineers could trace their origins to 18th century George Washington.

As early as 1755, when Washington served as aide to General Braddock—English commander during the early part of the French and Indian War—he experienced the need for military engineers or pioneers firsthand. As Braddock's forces advanced from Virginia to attack Fort Duquesne (located at what is now Pittsburgh), they built a road to move the supply wagons and cannons. In front of the combined British and Virginian forces, pioneers cut a road west over the Allegheny Mountains.¹⁸ Watching these early combat engineers, Washington must have filed away the lesson of the importance of infrastructure and the need to have the forces available to create it for military purposes.

Creating an American Corps of Engineers

Washington's later studies reinforced the importance of military engineers and sappers fulfilling important military functions, such as building field fortifications and conducting siege craft. This attitude was evident considering that after being named commander of the Continental Army on 15 June 1775, it took him *only a day* to appoint a Chief of Engineers. Colonel Richard Gridley of Massachusetts was named to that position, as he was one of the few colonials with experience in

constructing fortifications.¹⁹ Gridley's appointment was soon validated as his defensive plan provided protection for the militia in the staunch colonial effort at the Battle of Bunker Hill.

In early 1776, at Dorchester Heights, Gridley's successor, Rufus Putnam—in consultation with Washington—devised an ingenious method to erect aboveground fortifications, because of frozen earth conditions. These fortifications allowed the Continental Army to quickly emplace cannons, giving them command over the city of Boston. This positional advantage forced the British to abandon the city.

As Washington realized that the nature of the Revolutionary War would generally be defensive, he pleaded with Congress for more engineers.²⁰ Congress responded by recruiting foreign engineers like Frenchman Louis Duportail, who worked with Washington to establish a permanent and separate branch of sappers and miners, and Thaddeus Kosciuszko, who helped erect the formidable defenses at West Point. Washington later moved his headquarters there, as Continental soldiers continued to strengthen the Hudson River strongpoint. In 1778, Congress authorized three companies of engineers. The fledgling American Corps of Engineers enjoyed its finest hour at Yorktown in 1781 when Washington and his engineers conducted a successful siege that culminated by engineers clearing the way for the decisive assault that led to the British surrender.²¹

Advocating an American Engineering Institution

Washington's wartime experience convinced him that the new nation needed its own engineering educational institution. The long war had exposed America's dependence on European nations to provide military technical experts. On 1 May 1783, Washington wrote to Alexander Hamilton recommending the establishment of "academies, one or more for the instruction of the art military; particularly those branches of it which respect engineering and artillery, which are highly essential, and the knowledge of which is most difficult to obtain."²²



A statue of George Washington at West Point, the first engineering school in the United States

Congress disestablished the Continental Army after the war because of strong political views against a standing military. Washington, however, continued to advocate the need for an institution dedicated to engineering instruction in the United States. In an address to Congress in 1796, making his case, he stated,

*"Whatever argument may be drawn from the particular examples, superficially viewed, a thorough examination of the subject will evince that the Art of War is at once comprehensive and complicated; that it demands much previous study; and that the possession of it, in its most improved and perfect state, is always of great moment to the security of a nation. This, therefore, ought to be a serious care of every government: and for this purpose, an Academy, where a regular course of instruction is given, is an obvious expedient, which different nations have successfully employed."*²³

Washington did not live to see his academy established. He died in December 1799. In 1802, Thomas Jefferson signed legislation authorizing the establishment of a United States Military Academy. To overcome resistance to creating a purely military school, the federal law that established West Point called for an institution that produced trained officers who also possessed badly needed engineering skills for the nation.²⁴ West Point was the only engineering school of higher learning in the United States for fifty years. During that time, its graduates were largely responsible for the nation's initial railway lines, bridges, harbors, and roads.²⁵ If he had lived to see his vision materialize, George Washington would certainly have been content.

Conclusion

Washington's strong institutional support strengthens his impressive personal engineering achievements. This "Son of Martha" proved himself as an impressive practitioner and leader. Lacking formal instruction, Washington was a quick study who learned by doing. He was not afraid to apply his technical talents to solving practical farming, construction, infrastructure, or military engineering problems. Washington recognized the need for engineers in the United States Army and throughout American society. His early engineer advocacy, combined with his impressive personal portfolio, makes him one of America's great early engineers.

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Endnotes

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¹⁷Neal Fitzsimons, "George Washington: An Engineering Legacy," *The Military Engineer* (December 1999): 44. (Fitzsimons' article is the only one I could find that described Washington as an engineer. His work provided the original motivation for this paper.)

¹⁸Freeman, p. 81.

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